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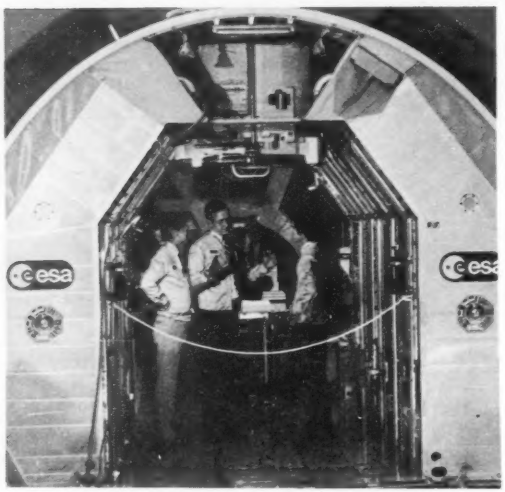
## About the Cover

Vice President George Bush officiated at a Spacelab delivery ceremony held at NASA's Kennedy Space Center, Fla. on Feb. 5. The ceremony celebrated Kennedy's receipt of the first Spacelab flight hardware, the first manned hardware to be housed in the spaceport's Operations and Checkout Facility since the Apollo-Soyuz Test Project in 1975. Spacelab, a milestone in European-American space cooperation, is scheduled for a September 1983 Shuttle launch. Shown below, Bush is given a private tour of the Spacelab hardware following the ceremony.

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# Letter from Washington

I welcome this opportunity to comment on President Reagan's proposed budget for NASA for Fiscal Year 1983.

This budget was prepared in the light of the President's two major policy priorities: reviving the economy and strengthening the national security. Inherent in those priorities are the principles of fiscal restraint and greater attention to NASA activities with national security implications.

Given the tightly constrained fiscal environment in which this budget was prepared, I believe we did well. This budget represents the Administration's commitment to the evolution of the Space Shuttle into an operational system. It also provides for continuing progress in major NASA program areas.

The President is requesting just over $6.6 billion for NASA for FY 1983. This represents an overall increase of $673 million, or 11 percent, over the revised plan for FY 1982. Factoring in inflation, we will have a slight increase in purchasing power throughout this fiscal year.

The $5.3 billion requested for research and development constitutes 81 percent, or the lion's share of the total request. More than half of this request, or $3.5 billion, is for Space Transportation, which includes not only the Shuttle, and its related systems—Spacelab and upper stages—but also our stable of expendable launch vehicles—the Scout, Centaur and Delta—as well.

The $3.5 billion would be divided about evenly between Shuttle production, system upgrading and performance augmentation on the one hand and Shuttle operations on the other. This is in contrast to previous years when funds for the latter lagged significantly below the former. The budget request reflects rapid movement into the operational phase, which we expect to begin in early Fiscal 1983 with the first operational flight.

The Shuttle's two orbital test flights were highly successful and proved that the concept of this extremely sophisticated, versatile and reusable space vehicle is technically sound. This budget is consistent with our immediate goal: to make the Shuttle the work horse of our civil and military efforts in space through the 1980s. The budget will support:

- A schedule of five planned launches including the first operational mission in FY 1983; 10 launches in FY 1984; and 13 launches in FY 1985;
- Continued progress in production of the third and fourth Shuttle orbiters, 103 and 104: (the second orbiter, 099, is scheduled for delivery during FY 1982);
- Provision of upper stages for planetary, geosynchronous and other special missions;
- Launch of the first Spacelab mission and continued procurement of the second Spacelab flight unit;
- Performance augmentation to reduce the weight of the solid rocket boosters and enhance the Shuttle's ascent performance for future NASA and national security missions;
- Preparation for a demonstration of the Shuttle's capability to retrieve an operational spacecraft—the Solar Maximum Satellite—for repair in orbit or return to Earth for refurbishment;
- The test, checkout and initial operation of the new Data Relay Satellite System (TDRSS).

In addition to increased emphasis on the Shuttle's operational capability, the FY 1983 budget will continue to support progress in aeronautical research and technology and in other vital areas of the space program.

Though some reductions have been made in the area of aeronautical research and technology, the FY 1983 request of $232 million will provide for technology advances in all aeronautical disciplines, stressing those which have been judged most vital in maintaining U.S. leadership in civil and military aviation. The budget preserves a strong research and technology base in aerodynamics, propulsion, materials and structures, aircraft controls and guidance, and human factors. It also maintains the experimental facilities and skilled personnel dedicated to this goal at the NASA research centers.

With Congressional approval, this budget will also support vital ongoing NASA programs. It proposes:

- $682 million for space science programs, emphasizing Spacelab missions; continued flight operations support anticipating Voyager's encounter with Uranus in 1986; developmental work on the Space Telescope, to be launched in 1985; on the Gamma Ray Observatory, to be launched in 1988; on the Galileo Jupiter

Probe, to be launched in 1985; on the support systems and science instruments of the International Solar Polar Mission, a joint NASA-European Space Agency program; and on the physics and astronomy explorers and suborbital activities.

- $320 million for important work in space applications missions, including the analysis of early data from Landsat-D's Thematic Mapper, a new generation Earth-scanning instrument which greatly improves our capability to study global resources; continued payload development projects for Spacelab, including materials processing; and analysis of early results from the International Search and Rescue Experiment, which will provide faster and more accurate data by satellite for locating aircraft or ships in distress.

The FY 1983 budget request also provides for continuing studies, investigations and definitions of mission options and advanced programs that will soon be possible because of the Shuttle's operational capability and flexibility. Possibilities under study include unmanned platforms in both low Earth orbit and geosynchronous orbit; a permanently manned facility, or space station, in low Earth orbit; and various elements of orbital test and transportation for their support.

I have given you brief highlights of our proposed budget for FY 1983. Like every other government agency we have had to reduce or delay some programs because of the urgent need to cut the rate of increase in Federal spending. But because of the importance to the nation of NASA's work and its spinoffs, we have come off well. And though there are no new starts, we are continuing with most of our ongoing activity in what we consider to be a balanced way.

Looking to the future, I am confident we will make the most of the opportunities the Shuttle affords as we open a magnificent new era of transportation, commerce and industrialization in space.

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Note: Fiscal year 1983 budget figures for NASA were released on Feburary 6; the preceding text is the statement of NASA Administrator James M. Beggs regarding this budget and its impact on NASA programs.

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NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

BUDGET SUMMARY
(Thousands of Dollars)

| BUDGET PLAN | FY 1981 | FY 1982 | FY 1983 |
|---|---|---|---|
| Research and development | 4,334,338 | 4,738,000 | 5,334,000 |
| Construction of facilities | 116,950 | 98,700 | 100,000 |
| Research and program management | 1,071,064 | 1,144,700[a/] | 1,178,900 |
| TOTAL BUDGET PLAN | 5,522,352 | 5,981,400 | 6,612,900 |
| OUTLAYS | 5,425,557 | 5,831,000 | 6,582,000 |

a/ Includes increased requirement of $41.4 million to cover revised salary rates effective in FY 1982.

RESEARCH AND DEVELOPMENT PROGRAMS

BUDGET PLAN
(Thousands of Dollars)

| Cognizant Office and Program | FY 1981 | FY 1982 | FY 1983 |
|---|---|---|---|
| SPACE TRANSPORTATION SYSTEMS/OPERATIONS | 2,728,600 | 3,090,100 | 3,467,800 |
| Space Shuttle | 1,995,000 | 2,163,000 | 1,718,000 |
| Space flight operations | 679,200 | 895,900 | 1,707,000 |
| Expendable launch vehicles | 54,400 | 31,200 | 42,800 |
| SPACE SCIENCE AND APPLICATIONS | 881,838 | 901,800 | 1,002,300 |
| Physics and astronomy | 323,700 | 323,500 | 471,700 |
| Planetary exploration | 175,600 | 205,000 | 154,600 |
| Life sciences | 42,188 | 39,500 | 55,700 |
| Space applications | 331,550 | 325,800 | 316,300 |
| Technology utilization | 8,800 | 8,000 | 4,000 |
| AERONAUTICS AND SPACE TECHNOLOGY | 384,000 | 344,000 | 355,000 |
| Aeronautics research and technology | 271,400 | 233,000 | 232,000 |
| Space research and technology | 110,700 | 111,000 | 123,000 |
| Energy technology | 1,900 | --- | --- |
| SPACE TRACKING AND DATA SYSTEMS | 339,900 | 402,100 | 508,900 |
| TOTAL | 4,334,338 | 4,738,000 | 5,334,000 |

RESEARCH AND PROGRAM MANAGEMENT

BUDGET PLAN
(Thousands of Dollars)

| INSTALLATION | FY 1981 | FY 1982 | FY 1983 |
|---|---|---|---|
| Johnson Space Center | 176,051 | 186,635 | 192,396 |
| Kennedy Space Center | 150,200 | 163,441 | 169,500 |
| Marshall Space Flight Center | 164,985 | 170,840 | 177,704 |
| National Space Technology Laboratories | 5,506 | 6,086 | 6,252 |
| Goddard Space Flight Center | 162,448 | 170,066 | 173,638 |
| Ames Research Center | 94,843 | 102,689 | 104,893 |
| Langley Research Center | 120,776 | 127,951 | 131,303 |
| Lewis Research Center | 99,886 | 106,960 | 110,591 |
| NASA Headquarters | 96,369 | 110,032 | 112,623 |
| TOTAL | 1,071,064 | 1,144,700[a/] | 1,178,900 |

a/ Includes increased requirement of $41.4 million to cover revised salary rates effective in FY 1982.

TOTAL NUMBER OF PERMANENT POSITIONS - END OF YEAR

| | | | |
|---|---|---|---|
| Johnson Space Center | 3,380 | 3,346 | 3,293 |
| Kennedy Space Center | 2,155 | 2,133 | 2,112 |
| Marshall Space Flight Center | 3,385 | 3,351 | 3,285 |
| National Space Technology Laboratories | 105 | 104 | 104 |
| Goddard Space Flight Center | 3,699 | 3,661 | 3,623 |
| Ames Research Center | 2,058 | 2,037 | 2,021 |
| Langley Research Center | 2,895 | 2,866 | 2,845 |
| Lewis Research Center | 2,690 | 2,663 | 2,479 |
| NASA Headquarters | 1,506 | 1,491 | 1,457 |
| TOTAL | 21,873 | 21,652 | 21,219 |

## 1981 in Review—Part II

In the January edition of *NASA Activities,* summary reports of major achievements in agency program areas of Space Transportation System, Space Transportation Operations, Space Tracking and Data Acquisition, Aeronautics, and Energy Research and Development were presented. In this edition of *NASA Activities,* we will conclude our review of last year's accomplishments with the program synopses for Space Science and Applications, Space Research and Technology, and International Affairs.

**Space Science and Applications**

The exploration of the solar system continued with the successful encounter of Saturn in August by the Voyager 2 spacecraft. Building on the knowledge gained by the Voyager 1 encounter, the second Voyager provided information to resolve the ring structure in detail comparable to a street map. The rings now appear to consist of at least three discrete bands—the classical A, B, and C rings.

The incredible structure, which at one point caused Voyager imaging chief Dr. Bradford Smith to insist that there were not just thousands, but thousands and thousands of ringlets, is now undergoing reexamination. The various Saturn moons, sizable chunks of debris (the so-called shepherding satellites and others) and the enormous mass of Saturn itself are probably imprinting on the rings a harmonic wave-like feature representing gravitational influences among the various bodies. This theory has outlasted the debris-sweeping satellite theory, which was favored prior to the second encounter.

The thickness of the rings was deduced to be considerably less than the length of a football field. In human terms, this makes the rings the equivalent of a phonograph disk 40 km (25 mi.) in diameter—still one of the strangest objects in the solar system.

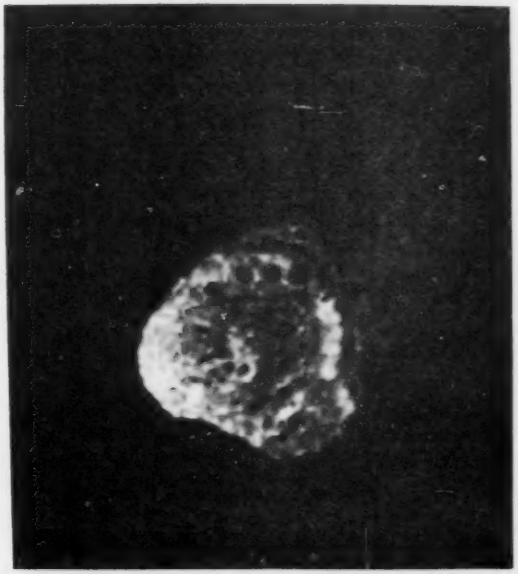
The atmosphere of Saturn was determined to operate dynamically different from Jupiter. There are no counter-cyclonic wind jets alternating within the cloud bands of Saturn; rather there is an equatorial jet stream of incredible speed—more than 1,770 km/hr (1,100 mph). This led atmospheric physicists to postulate that the dynamics of Saturn's weather are much more profoundly related to internal structure within the planet itself. A series of barrel-like atmospheric cells, each nesting inside another, was conjectured to represent the model of Saturn. Jupiter, by contrast, consists of a series of upwelling and downwelling zones separated by rapidly changing slipstreams creating a literal maelstrom of eddies.

The new Saturn class of moons, the mostly icy satellites, also were examined in increased detail and the surfaces of nearly all 17 moons mapped in detail. The extremely unusual moon, Hyperion, was photographed for the first time. This moon—perhaps a captured object—is orbiting Saturn in a manner which cannot be explained by conventional accretionary disk models. This moon has been described as being "Campbell soup-can shaped."

Voyager 2 is now on a trajectory which will intersect Uranus in January 1986. Scan platform problems encountered during the Saturn encounter are now mostly cleared and there is high confidence that the Uranus encounter will occur with no additional hitches.

Pioneer 6, 15 years after its launch, continues to return interplanetary and solar science information. This is the longest mission ever achieved for an interplanetary spacecraft. All Pioneers from 6 through 11 continue to function well.

The Pioneer 10 spacecraft achieved a milestone—it is now more than 25 thousand million miles from



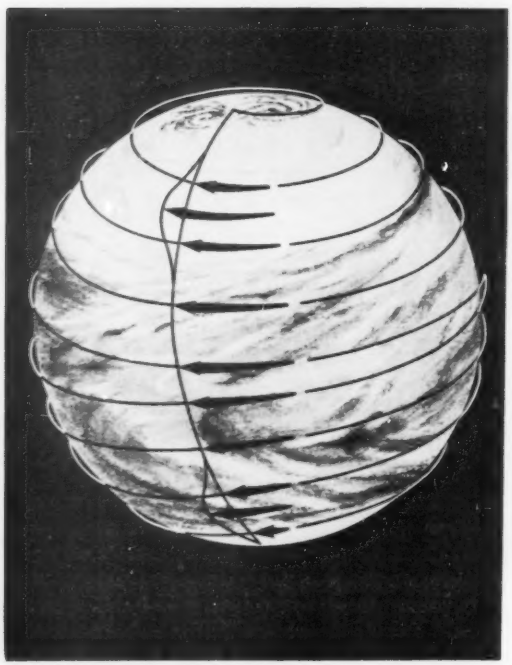
Voyager 2's view of Saturn's moon Hyperion—a moon never before photographed. The surface of Hyperion is pock-marked with many meteorite impact craters; it is possible that one of these impacts jostled Hyperion into its gravitationally unstable condition.

the Sun. Pioneers 10 and 11 are now providing first hand information about the nature and extent of the solar wind. This extended solar atmosphere gives way at some point, totally unknown, to the even more tenuous "atmosphere" of the Milky Way Galaxy. This limit, the heliopause, is the object of the extended Pioneer mission.

The Pioneer Venus mission continues to produce scientific results concerning the cloud-shrouded yellow neighbor of Earth. Long term studies now show that Venus has two different cloud states which alternate in dominance. The two patterns are a mid-latitude jet stream pattern which gives way over a period of several years to a cloud-and-wind pattern which behaves like a single air mass body.

The high altitude haze layer also has been shown to appear and disappear over periods of several years. Other Venus findings include the relationship of the tremendous Venus surface temperatures, 482 degrees Celsius (980 degrees Fahrenheit), to the long-term effects of a carbon dioxide atmosphere.

Scientists working for NASA discovered a natural carbon dioxide laser operating within the atmosphere of Mars. The power of the Red Planet's natural laser is about five times the power production of the United States. This natural laser provides another clue to the influences working within atmospheres to heat them. Past theory was held that a thermodynamic balance exists within the whole atmosphere.



Artist concept of the circulation patterns of Venus' jet streams which alternate in dominance over the yellow planet.

Researchers examining meteorites retrieved by NASA from the Antarctic have found miniscule diamonds within an iron-type sample. The diamonds are believed to have been formed in space during a great collision that probably took place in the asteroid belt many millions of years ago. Other NASA researchers theorized that the pressure and temperature of methane on Uranus might be conducive to the natural creation of diamonds on that green ringed planet. However, none of these diamonds has any commercial value due to their incredibly small size and the extreme difficulty of retrieving them.

The High Energy Astronomy Observatory program came to the end of its successful mission with the HEAO-2 spacecraft depleting all of its attitude control gas in June and the HEAO-3 depleting all of its control gas in August. These spacecraft, along with HEAO-1, were pioneering X-ray astronomy observatories and built a tremendous baseline of information about the X-ray universe. This work was preceded by the Uhuru satellite which had proved that X-ray astronomy could be performed. The HEAO-3 was a mapper while the HEAO-2 was a fine pointing observatory. Among their many discoveries was the possibility of a black hole at the X-ray source Cygnus X-1.

The Johns Hopkins University was named to be the location of the Space Telescope Institute. The Association of Universities for Research in Astronomy, selected to operate the Institute for NASA, has chosen Johns Hopkins as its partner in this venture. The Institute will operate as an observatory for scientists who use the Space Telescope, scheduled for launch aboard the Shuttle in 1985.

A new laser detecting and ranging device (LIDAR) was flown for the first time aboard a NASA aircraft. This new instrument uses light to sample atmospheric constituencies such as ozone and is intended for further testing aboard a Shuttle flight.

The Landsat-3 spacecraft's multispectral scanner was removed from operational service because of a malfunction. This leaves only the multispectral scanner from Landsat-2 to provide user information. The Landsat-3 television imaging system continues to operate.

The OSTA-1 payload successfully flew aboard the second Columbia flight in November. This payload, the first scientific payload to fly on the Space

Transportation System, carried a synthetic aperture, Earth-looking radar; an advanced infrared radiometer, an experiment to automatically map the plankton concentrations in the world's oceans; a test instrument to determine if Landsat-type spacecraft can be further automated; and a carbon monoxide mapper. Inside the cabin the crew operated a lightning detection device and monitored the performance of a plant growth experiment.

Except for the plant growth experiment, which failed due to the shortened flight time of STS-2, the rest of the experiments were judged successful by their investigators. The radar, in particular, was a spectacular success, showing Earth terrain features never before mapped from space. The entire payload was chosen to provide information and data to aid in designing a new generation of Earth resources orbiting satellites.

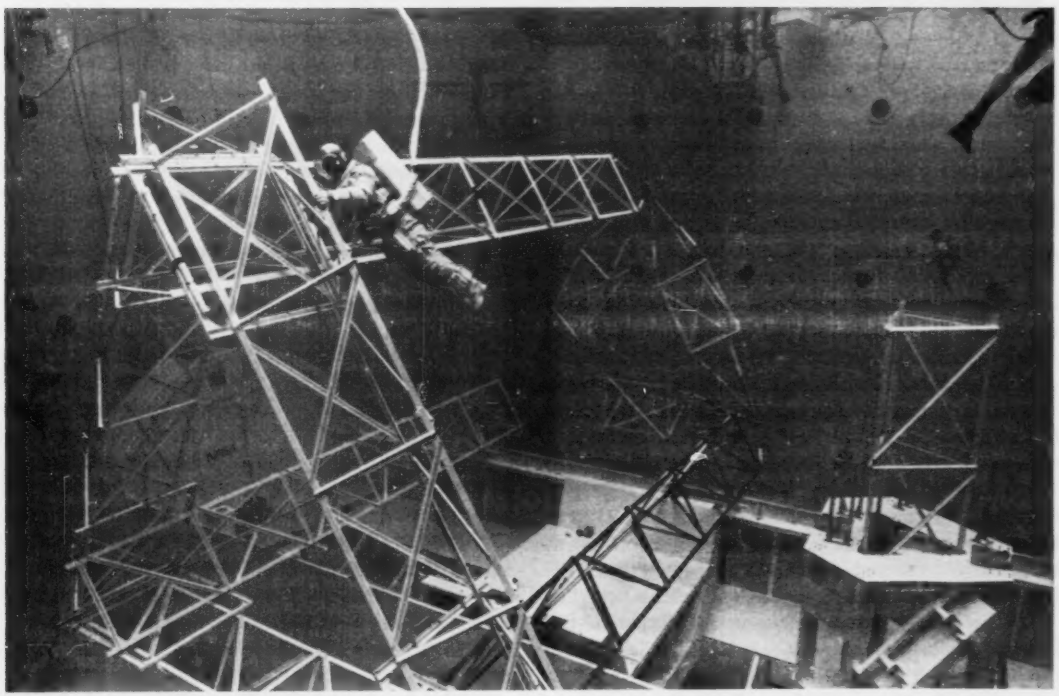
**Space Research and Technology**

NASA research and technology developments in 1981 continued to expand the U.S. technology reservoir supporting national space capabilities.

An image processor designed for robotic vision applications was successfully demonstrated at NASA's Jet Propulsion Laboratory, Pasadena, Calif., for the first time. Vision capability is the most valuable sensor for robotic control during automated satellite servicing and in-space structure assembly and construction. The image processor could visually track objects at a 15 video-frames-per-second rate. The laboratory demonstration is an early step toward control-oriented computer vision system development for space robotics.

A mobile work station concept from which space-suited astronauts could assemble large structures in space was developed and tested at NASA's Langley Research Center, Hampton, Va., and Marshall Space Flight Center, Huntsville, Ala., under simulated space conditions. The station is designed for operations attached to the Space Shuttle or as a free flyer. The astronauts would be attached by foot restraints to the station, freeing their hands for the assembly tasks.

Concepts were developed for assembly, without tools, of large structures in the weightless environment of space using lightweight composite columns and unique, specialized joints. Assembly of a



Mobile work station assembly concept being tested in the neutral buoyancy tank at NASA's Marshall Space Flight Center, Huntsville, Ala.

38-element structure in both a 1 g laboratory environment and in a neutral buoyancy tank simulating the weightlessness of space has shown the structural concepts to be practical.

An experimental computer program for automatically planning and scheduling spacecraft action sequences was designed and developed at the Jet Propulsion Laboratory. The program combines artificial intelligence technology with operations research and techniques to automatically perform tasks which typically require support from a number of mission operations specialists. The experimental computer program was successfully demonstrated on realistic Voyager-like spacecraft sequences spanning a six-hour operational period involving dozens of spacecraft actions and events.

The orbital flight tests of the U.S. Space Shuttle also began a unique flight research program supporting NASA's advanced (21st Century) space transportation program. Flight research experiments onboard measure orbiter performance, providing precise engineering data for the timely and evolutionary development of future space transportation concepts.

**International Affairs**

A milestone in European-American space cooperation occurred Dec. 4, 1981, when the European Space Agency Spacelab unit was accepted by NASA at a rollout ceremony in Bremen, West Germany. Spacelab is a major element in the NASA Space Transportation System with facilities and equipment similar to laboratories on Earth but adapted for zero gravity. The first Spacelab mission is currently scheduled for September 1983.

The second test flight of the Space Shuttle (STS-2) in November carried for the first time the Canadian-developed Remote Manipulator System (RMS) and the first European-developed Spacelab hardware, a pallet, into space. The Remote Manipulator System, or arm, is designed to place payloads into orbit and retrieve them, as well as for other freight-handling activities in space. Astronauts Joe Engle and Richard Truly operated the arm in all of its modes, ranging from fully automatic, in which it is programmed in advance by computer to perform a series of operations, to fully manual in which it is operated directly from a control panel that bypasses the computer.

The five OSTA-1 experiments on STS-2 that were flown in the orbiter's payload bay were carried on a special "U"-shaped structure called an orbital flight test pallet. The 3-by-4-m (10-by-13-ft.) aluminum frame and panel structure weighing 1,218 kg (2,685 lb.), is an element of Spacelab, a reusable, modular research facility being developed for the Space Transportation System by ESA in cooperation with NASA.

The Spacelab pallet carried on STS-2 was an engineering model of the flight version pallet. This engineering unit was certified for flight and was adapted for use with special subsystems which provide interfaces between the payload and orbiter systems. The subsystems were developed by NASA using, for the most part, off-the-shelf hardware.

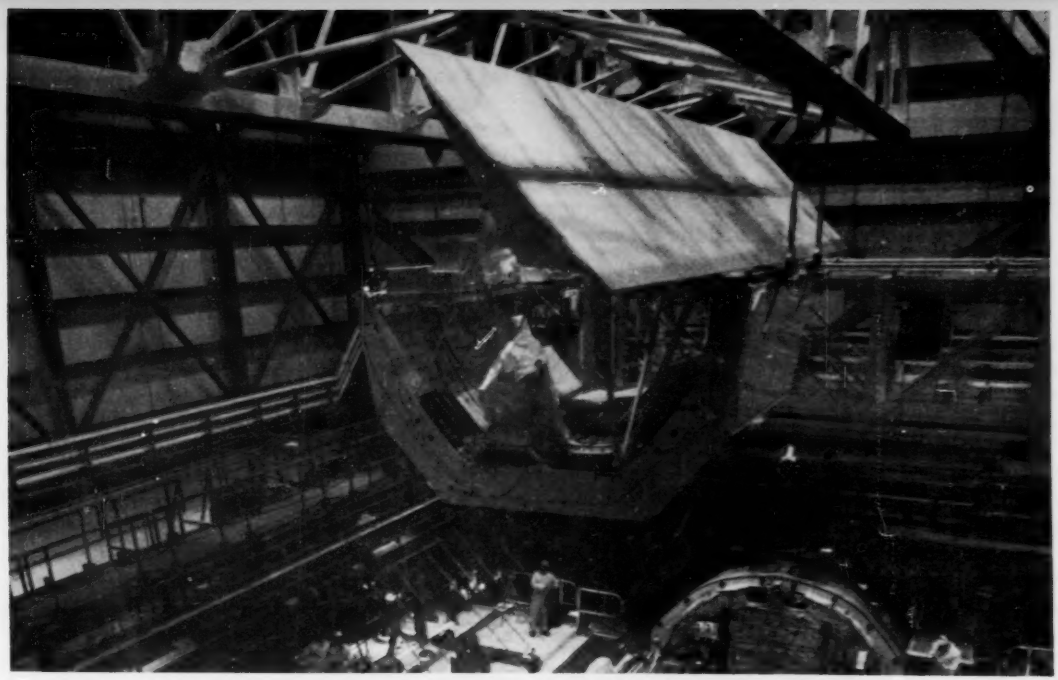
The pallet, developed for ESA, is built by the British Aerospace Dynamics Group under subcontract to ERNO Raumfarttechnik GmbH, the prime contractor for ESA.

NASA and the West German firm Messerschmitt-Boelkow-Blohm GmbH (MBB) signed a launch services agreement in June for the first flight of the Shuttle Pallet Satellite (SPAS-01) which will be carried into orbit on the third Space Shuttle operational flight, STS-7, now scheduled for February 1983. It will be the first payload to be deployed and retrieved by the Canadian-built arm.

MBB's objective is to conduct materials processing research experiments while SPAS is in the Shuttle payload bay. After these experiments are finished, NASA will use the payload in a test of the Remote Manipulator System's deployment and retrieval capabilities during the five-day mission. A 70-mm camera mounted on SPAS will provide photo coverage during deployment, free flight, retrieval and reberthing on the Shuttle.

MBB is the fifth international user to sign a Shuttle launch service agreement with NASA, joining India, Indonesia, Telesat Canada and Intelsat. The agreements signed with India, Telesat Canada and Intelsat also provide for launches aboard NASA expendable launch vehicles—Delta or Atlas Centaur—prior to the Shuttle becoming operational. In addition, the Arab Satellite Communications Organization (Arabsat), Australia, Colombia, the Federal Republic of Germany, Italy, Japan and Luxembourg have reserved launches aboard the Shuttle or NASA expendable launch vehicles, and a number of other countries are expressing interest.

On May 23 and Nov. 15, 1981, NASA launched Intelsat V spacecraft aboard Atlas Centaur launch vehicles. The launch service agreement with Intelsat, which was signed in 1980, provides for launch and associated services for six Intelsat V spacecraft. The next two satellites in the series also will be launched aboard Atlas Centaurs, while the fifth and sixth satellites are scheduled to be launched from the



Spacelab engineering model pallet being installed aboard the Columbia for the Shuttle's second flight last November.

Space Shuttle. In addition, NASA and the Italian National Research Council (CNR) signed a Memorandum of Understanding in July 1981 that provides for a launch and associated services for the Italian Research Interim Stage (IRIS) payload on the Space Shuttle.

In 1980 NASA agreed to include two European scientists in the mission specialist astronaut training program in recognition of the substantial contribution ESA is making to the Space Transportation System by funding development of Spacelab. ESA is reimbursing NASA for the costs of this training. The two European scientists completed the first phase of their training at the Johnson Space Center in Houston during August 1981.

ESA decided in September, that one of the mission specialist trainees, Dr. Wubbo Ockels, would transfer to NASA's Marshall Space Flight Center in Huntsville, Ala., to resume payload specialist training in preparation for the first Spacelab flight. Dr. Claude Nicollier, the other trainee, will continue as an ESA astronaut at Johnson for possible selection as a mission specialist for flight on board the Shuttle with the planned German "D-1" Spacelab mission in 1985.

The Infrared Astronomical Satellite (IRAS), which is to carry out an all-sky survey of discrete infrared sources, is a cooperative project involving the United States, the Netherlands and the United Kingdom. The United States is producing the cryogenically-cooled infrared telescope system; the Netherlands is furnishing the satellite; and a mission control center will be established in the United Kingdom. Spacecraft testing of IRAS was completed in September 1981 in the Netherlands. The spacecraft was then shipped to the United States where it is going through its final development and test phase leading to a launch in August 1982.

The Active Magnetospheric Particle Tracer Explorer (AMPTE) mission will study the interaction between the solar wind and the Earth's magnetosphere through release of chemical tracer elements. AMPTE is a dual spacecraft mission with NASA providing the Charge Composition Explorer and West Germany, the Ion Release Module. NASA will launch the two spacecraft on the same Delta vehicle in 1984. The development phase of the project began in 1981. A Memorandum of Understanding between NASA and the Ministry for Research and Technology of the Federal Republic of Germany

was signed Oct. 15, 1981, outlining the responsibilities for each side.

Development continued during 1981 on Galileo, a cooperative project with the Federal Republic of Germany which will continue the exploration of Jupiter and its environment. The Federal Republic of Germany is contributing a Retro Propulsion Module to inject the Galileo spacecraft into Jovian orbit, as well as other mission hardware. Critical design reviews of the mission hardware and systems requirements reviews have been completed. Several components are nearing completion and the development model for the probe's heat shield recently passed tests at NASA's Ames Research Center, Mountain View, Calif. Launch of the Galileo orbiter and atmospheric probe is now planned for 1985.

Development also continued on the Space Telescope, a cooperative project with the European Space Agency, which is scheduled for launch on the Space Shuttle in 1985.

Announcements of opportunities were issued worldwide for participation in further scientific analysis of data acquired in a variety of NASA missions ranging from Viking-Mars data and Apollo lunar samples to astrophysics observations from the High Energy Astronomy Observatories. As a result of previous such announcements, scientists were selected for definition studies of scientific instruments for possible flight on the Solar Optical Telescope, the Upper Atmospheric Research Satellite and the Origin of Plasma in the Earth's Neighborhood program.

During 1981, planning proceeded on the multilateral Search and Rescue (SARSAT) program. In addition to the United States, Canadian, French and Soviet participation previously agreed upon, Norway has been added as an investigator on the project.

NASA and the Indonesian National Institute of Aeronautics and Space signed a Memorandum of Understanding for the establishment of a Landsat ground station at Pekayon, near Jakarta, Indonesia.

Ten foreign Landsat ground stations are already in operation outside the United States: Prince Albert, Saskatchewan and Shoe Cove, Newfoundland, Canada; Cuiba, Brazil; Fucino, Italy; Kiruna, Sweden; Tokyo, Japan; Hyderabad, India; Alice Springs, Australia; Mar Chiquita, Argentina; and Harkbeesthoek, South Africa.

A ground station in Thailand is receiving test signals and a number of other ground stations are in the planning stages.

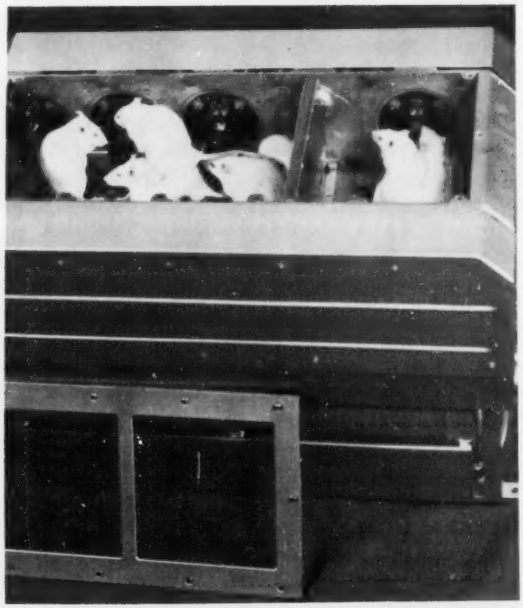
In 1981 NASA negotiated a 10-year renewal of the Interagency Agreement for the Operation of Tracking Facilities in Australia.

Agreements were also concluded for the establishment of a Shuttle Support Communications Facility in Gaborone, Botswana, and the upgrading of the Shuttle support facility in Dakar, Senegal.

NASA provided, through its Spacecraft Tracking and Data Network (STDN), reimbursable tracking support for ESA's Ariane launchings and the Meteosat II satellite.

Reimbursable tracking support was also provided to Japan for its Astro-A and GMS-II satellites.

Mutually beneficial cooperation between the United States and Soviet Union in the area of planetary research was developed further during 1980. In October, the U.S./U.S.S.R. Joint Working Group on Near-Earth Space, the Moon and Planets met in San Francisco to review the status of collaborative efforts in process, exchange information on future plans for lunar and planetary exploration and identify potential areas of mutual interest for future bilateral cooperation. Scientists from both countries exchanged the results of the U.S. Pioneer Venus and Soviet Venera 11 and 12 missions which



Rat mating chamber launched aboard Cosmos 1129 in Fall 1979 with two males and five females in separate compartments. The dark discs are feeding stations where a paste and water diet were dispensed.

encountered the planet in December 1978, and agreed to continue their joint analyses of data from these missions.

U.S./Soviet cooperation in space biology and medicine continued as well. The United States is preparing for participation in the Soviet Cosmos 82 biosatellite mission with primates. Experimenters in the United States will be involved in studies of primate biorhythm and cardiovascular activity, and in biological studies using rats. A new program of collaboration in studies of calcium metabolism and bone mineral loss resulting from manned spaceflight yielded important data which will aid in the understanding of the effects of weightlessness on humans. In November, a Symposium on Cardiovascular Changes Resulting from Spaceflight was held in conjunction with the Twelfth meeting of the U.S./U.S.S.R. Joint Working Group Meeting on Space Biology and Medicine, in Washington, D.C. The symposium brought together over 50 specialists from both countries to exchange information and present the results of ground-based and inflight research in this area.

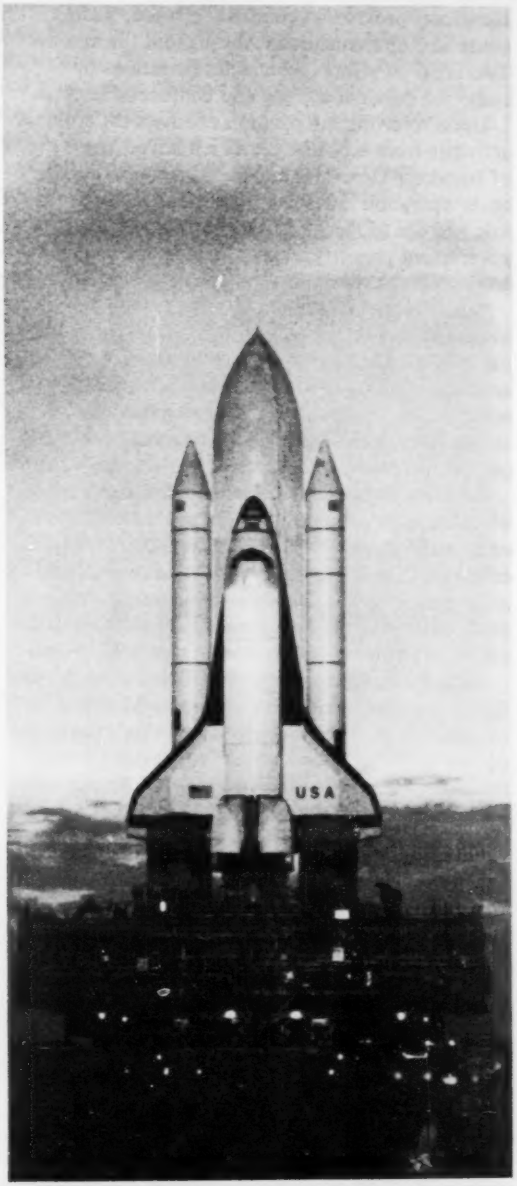
A letter agreement was concluded in May 1981 between NASA and the Italian National Research Council for an advanced development study of a Tethered Satellite System. The project involves a data-gathering satellite suspended from the Shuttle on a tether up to 97 km (60 mi.) long.

Should the Tethered Satellite System receive budgetary approval, the Italians will be responsible for the satellite and NASA for the tether and deployer mechanism, as well as for overall systems integration.

Significant progress is continuing with implementation of a series of cooperative studies and projects with Japan. These projects were reviewed in September 1981 in Tokyo at the first meeting of the Joint Committee on U.S./Japan Cooperation in Research and Development in Science and Technology.

Development of the reusable space plasma physics experiments facility (SEPAC) in Japan is near completion at the end of 1981 and will be delivered to the United States in 1982 for integration for the Spacelab 1 mission.

Proposals were selected for participation in the Crustal Dynamics Program using space geodetic data for application to Earth movement measurements and earthquake modeling. Over 20 foreign investigators from Germany, France, the Netherlands, Canada, China, Chile, Peru, Venezuela, Spain, Switzerland, Australia and New Zealand were chosen. Negotiations continued with other countries including Italy, England and France for other cooperative geodynamics studies activities.




Rollout of the Space Shuttle Columbia to Kennedy Space Center's Launch Pad 39A on Feb. 16, several days ahead of schedule. The next launch of the Columbia is set for March 22.

## Inspector General Activities

During the past several months, NASA's Office of the Inspector General (OIG), in cooperation with NASA management and employees, has made significant progress in combatting fraud, waste, abuse and mismanagement throughout the agency. Two areas of effort involved investigations of suspected criminal activity and conflict of interest.

Upon receiving information of suspected criminal activities from a NASA center employee, the Office of Inspector General initiated a three-month undercover operation. Suspected violations included the sale and use of illegal drugs, drunkenness, theft of government property, sexual harassment, gambling and dereliction of duties.

With the cooperation of NASA management and assistance from the FBI and local police department, the operation was concluded with the arrests of six contractor employees for the above cited charges. In addition, one contractor employee voluntarily resigned, two were suspended for three days each for neglect of duties and six received written reprimands.

An investigation was also conducted at the request of center management which led to the resignation of a NASA employee. The investigation revealed the employee in addition to his NASA center employment also served as an officer of a company that produced a material both developed by NASA and associated with his NASA employment.

Becuse the employee was directly involved in the firm's financial transactions, this created a conflict of interest which is a violation of NASA's standards of conduct. The investigation also established that the employee falsified his Statement of Employment and Financial Interests and failed to request approval of outside employment as required by NASA regulations.

Recommendations from the Office of the Inspector General resulted in NASA management requiring the employee to either divest himself of his outside business or to resign from NASA; the employee elected to resign.

NASA's Office of the Inspector General urges all employees to continue with such efforts in meeting the challenge of improving NASA programs. Suggestions for eliminating waste and mismanagement are welcome. Identities can be confidential. There is a 24-hour answering service in the Washington, D.C. area at 755-3402 or a toll-free number for all other areas at (800) 424-9183.

Written suggestions or complaints should be mailed to: NASA Inspector General, P.O. Box 23089, L'Enfant Plaza Station, Washington, D.C. 20024.

## Applications Technology Satellite Repositioned

NASA has begun relocation of the geosynchronous Applications Technology Satellite-1 (ATS-1) from its present position at 149 degrees west longitude to a new position about 50 degrees farther west to 162 degrees east longitude.

The present location at 149 west longitude requires maximum thruster use to maintain the orbit position. Relocating to 162 east longitude puts the satellite into a more stable position where the power from onboard thrusters required for station keeping is reduced substantially.

At its location of 149 degrees west, the satellite required twice weekly station keeping management. Estimates of onboard fuel supplies indicated the useful lifetime of the satellite would end sometime mid-1982. Several options concerning the extension of this lifetime have been examined by the Goddard Space Flight Center, Greenbelt, Md., including the present action to move the spacecraft to 162 degrees east longitude.

This action will prolong the orbital station keeping period of ATS-1 through 1983 and will reduce station keeping activities to quarterly from bi-weekly. This new position also improves the satellite's "look angle" to more westerly islands in the Pacific Basin.

The ATS-1 satellite is the oldest synchronous communications satellite still in use. Present experiments include voice transmissions among 11 Pacific island nations, the Trust Territory of the Pacific, Australia, New Zealand, Hawaii and California. Other experiments provide medical care delivery communications for Alaska, technology transmissions between Japan and Australia, and coordination of oceanic research vessels in the Pacific and Gulf regions.

The ATS-1 was launched on Dec. 7, 1966, and has been a pioneer in the use of communications satellites for health care delivery, education, public safety, emergency communications and mobile land and maritime applications.

The maneuver to reposition the ATS-1 satellite to 162 degrees east is expected to take about eight months to complete. Full communications with ATS-1 will be maintained throughout the move period with periodic adjustments of ground station antennas to keep the satellite in view.

## Spaceport Citrus Survives January Freeze

NASA's Kennedy Space Center may be best known as the home of the Moon shots and Space Shuttle launches but it's also the site of some of the earliest commercial citrus activity in the country. The land which is now Kennedy Space Center is ideally located for citrus cultivation. Large, brackish lagoons and the Atlantic Ocean tend to insulate the area from the cold, and groves there have historically fared better than most others in the state.

It was no different this year following the recent invasion of the sunshine state by sub-freezing weather called the "Siberian Express." Fresh Florida citrus may be in short supply this year because of damage incurred by this weather but among the boxes of oranges and grapefruit shipped to satisfy the cravings of northern markets will be some from the nation's spaceport.

A preliminary assessment of the effects of the early January freeze on Kennedy's citrus groves indicates a fair portion of the crop will still be marketable as fresh fruit, rather than having to be sent to frozen concentrate plants like much of this season's crop on the mainland.

"I was pleasantly surprised," said Harvey Page, citrus manager at KSC and an employee of the U.S. Fish and Wildlife Service. "It appears we had minimal damage in the areas south of the VAB." The VAB—Vehicle Assembly Building—is where the Space Shuttle is readied for launch and three fifths of Kennedy's groves are located south of the huge structure.

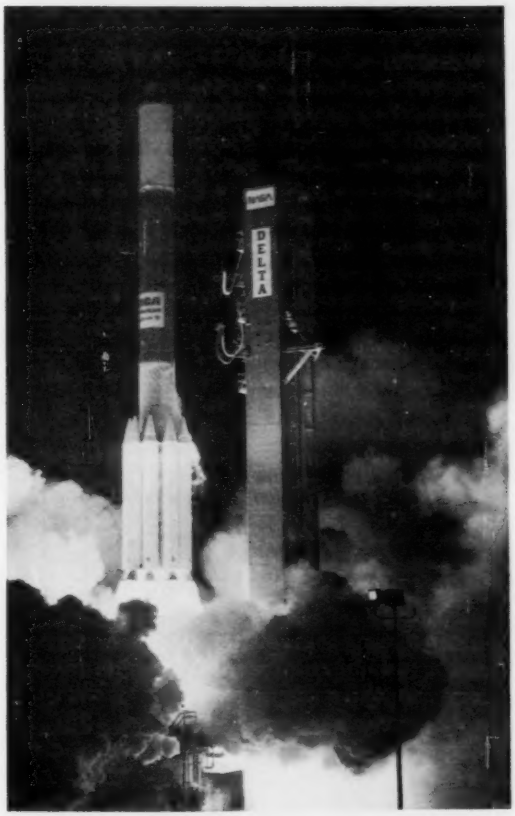
The first commercial groves on what is now the Kennedy Space Center were planted in the 1820's and they survived devastating freezes in 1835 and 1895. The area's ability to protect citrus trees from the cold weather encouraged other growers to plant groves on the Island.

By the time NASA began acquiring the property in 1962, there were groves scattered throughout the entire tract. They ranged in size from an acre and a half to several hundred acres. The fruit harvested from the Spaceport is among the finest grown in the state. "It's top quality Indian River fruit," says Page. "And as far as production, our groves are as good or better as any others of similar age."

For the first 10 years after the government acquired the property, the groves were leased out individually. Contractors competed for the right to operate the groves by bidding the percentage of the crop's value that would be turned over to the Government's general fund. Former owners were permitted to match the high bid.

But with a lot of small tracts, Page explained, it was uneconomical for the operators to invest in the long-term maintenance work necessary to ensure a grove's long-range health. So in the early 1970's the government grouped the groves into tracts of approximately 250 acres each. This made it economical and it became a contractual obligation for the winning bidder to perform tasks such as ditch maintenance and tree replacement.

A recent study by two agricultural experts employed by the state showed the Kennedy Space




**First Launch of 1982**—RCA Satcom E successfully launched aboard a Delta launch vehicle from the Eastern Space and Missile Center, Cape Canaveral Air Force Station, Fla., on Jan. 15. This satellite joins three other RCA commercial communications satellites in geosynchronous orbit as part of a diversified commercial communications system. The 24-channel satellite will be used to distribute video programming to cable television systems throughout the United States.

Center citrus crop contributes about $4.5 million annually to the local economy. This is based on production figures for the 1979-80 crop year. The on-tree value of the crop in that year was $2.5 million. The activities involved in harvesting the fruit and getting it to market were added to the on-tree value in determining the contribution to the area economy.

The fruit grown on the Space Center can end up at roadside shops which sell fresh citrus to tourists or in the produce and frozen foods section of your grocery store. Page said the biggest single producer in the spaceport crop is colored (red and pink) grapefruit. After that, Valencia oranges account for the most boxes. Other major varieties grown here include Navels, Temples, and Tangelos. The harvesting season begins in November and runs into July.

## Telescope Cooling System Tested at Marshall

A large infrared telescope cooling system is undergoing thermal performance tests by the Space Sciences Laboratory, NASA's Marshall Space Flight Center, Huntsville, Ala. The cooling system, part of the Marshall-managed Helium-Cooled Infrared Telescope Experiment planned for launch with Spacelab 2 in November 1984, must maintain the infrared detectors at a super-cold temperature in order for the instrument to work.

James Jolley, an electronic technician in Marshall's Space Sciences Laboratory, examines the dewar section of a model of the Helium-Cooled Infrared Telescope Experiment. The actual dewar, a seven-foot-high container for liquid helium, is shown in the background. The dewar and other portions of the telescope cooling system are currently undergoing tests at Marshall.

"Since the telescope will be scanning newly forming stars and other sources of infrared radiation, which is emitted from warm objects, we have to make sure that the instrument doesn't measure infrared within itself," said co-Investigator Dr. Eugene Urban of the Space Sciences Laboratory. "So we have to keep parts of the telescope as cold as possible—about minus 450 degrees Fahrenheit."

Liquid helium, the coolant for the system, will be stored during the mission in a 250-liter container called a "dewar," a container sometimes compared to a thermos bottle, although far more sophisticated. It has vacuum jackets, insulation, thermal radiation shields and a highly complicated plumbing system.

Vaporized helium, drawn from the liquid in the dewar and nearly as cold as the liquid helium itself, will be circulated through various channels of the telescope to keep the instrument near absolute zero—the coldest possible temperature, at which all molecular action ceases.

The mechanical and cooling systems of the experiment are under Marshall Center development, while the telescope itself is being designed by the University of Arizona under a joint effort agreement among Marshall, the university and the Smithsonian Astrophysical Observatory. The University of Alabama at Huntsville is assisting in the development of the dewar system.

Among the tests being conducted is a measure of the flow rate of the helium as it boils off from the liquid, which is a determinant of thermal efficiency. Scientists are also measuring the temperatures of various components of the cooling system, to ensure that the super-cool conditions are evenly maintained.

"One of the objectives of these tests is to see how long the cooling system can store such a cold liquid," said Dr. Dan Ladner, a Space Sciences Laboratory physicist who assists Urban in the telescope experiment. "We want the cooling system to last for several weeks, because the dewar would be filled with liquid helium one or two weeks before the launch of Spacelab 2 and then undergo a mission of seven days. So we'd like to see a capability of the dewar to maintain the helium for perhaps 30 days."

Testing of the cooling system will continue until March.

## Edelson Heads NASA Office of Space Science and Applications

Dr. Burton I. Edelson, senior vice president of COMSAT General Corp., was named NASA Associate Administrator for Space Science and Applications, effective Feb. 14. He succeeded Andrew J. Stofan, who had filled the position in an acting capacity. Stofan will remain as an advisor to Edelson until he moves into another senior management position within NASA.

Edelson will be responsible for all of NASA's Space Science and Applications programs, as well as the activities of the Jet Propulsion Laboratory at Pasadena, Calif., and the Goddard Space Flight Center, Greenbelt, Md.

Edelson joined the Communications Satellite Corp. in 1967 as assistant director for COMSAT Laboratories and in 1973 was named director of COMSAT Laboratories.

In March 1979 he was elected vice president of COMSAT, and he assumed his present position in September 1980. Prior to joining COMSAT, he served as an engineering officer in the U.S. Navy with assignments on the staff of the National Aeronautics and Space Council at the White House and in the Office of Naval Research.

A graduate of the U.S. Naval Academy, Edelson earned his master's and doctorate degrees from Yale University.

He is a Fellow of the Institute of Electrical and Electronics Engineers and of the American Institute of Aeronautics and Astronautics. He is a member of several U.S. government advisory committees and recently served on the NASA Transition Team for the Reagan Administration.

**Aviation Beginnings**—Historic photo of the Wright brothers' third test glider being launched at Kill Devil Hills, N.C. in 1902. Wilbur Wright is at the controls, Orville Wright is at left, and William Tate (a local resident and friend of the Wright brothers) is at right. This photo was part of an exhibit of the Wright brothers work which was on display at the NASA Langley Visitor Center.

## Monitor Provides Information on Shuttle Cargo Bay Environment

The Induced Environment Contamination Monitor taken into space aboard NASA's second Space Shuttle flight last November has provided the first information about the environment in the Shuttle orbiter's cargo bay in orbit.

The 10 instruments that comprise the monitor revealed the following:

- Humidity remained low in the cargo bay area during ascent and descent;
- Particulate matter of sizes greater than 5 micrometers were relatively absent from the bay, but particles less than 5 micrometers in diameter exceeded expectations;
- The cargo bay was successfully sealed from engine byproducts during liftoff and descent;
- Water molecules and other early-mission contaminants began boiling off rapidly and there was a 90-percent reduction after approximately 35 hours in orbit;
- Other data was obtained showing that when the orbiter's attitude control system is used, or a water dump is made, a temporary "cloud" of particulates is generated.

"In one instance," Project Scientist Edgar Miller said, "the orbiter was flying with the cargo bay open pointed straight ahead. At that point, molecular readouts were high because orbiter-generated particulates were deflected by the atmosphere back into the bay. Procedures will have to be worked out so that such instances do not occur when sensitive telescopes and other scientific instruments are in use; longer flight times on future flights are essential in understanding our data," he added.

Of major significance is the fact that every contamination producing activity such as thrust firings and water dumps, was clearly identified. This is important for it assures that during future missions, a differentiation can be made in evaluating contaminents that may be present from other sources.

The desk-sized package of sensors has been undergoing an extensive month-long analysis at NASA's Marshall Space Flight Center, Huntsville, Ala., where it was developed. A preliminary report on the data produced by the monitor during the Shuttle mission indicates that the monitor performed up to design expectations.

The 54-hour duration of the second Shuttle mission provided insufficient time to evaluate the potential breadth of contamination. The worst case potential for contamination is when the payload bay is exposed to the Sun, a condition which did not occur on the flight.

However, with the bay orientation that did exist, no surprises with regard to contamination were encountered, Miller added. "The contamination monitor systems performed normally throughout the mission and responded properly to all commands," he said. "The second Shuttle flight proved out the operation of the monitor, and its instruments added significantly to our knowledge of the orbiter's induced environment."

The third Shuttle flight will enhance the capability of the monitor because of the planned solar orientation of the bay producing high temperatures as compared with the relatively mild temperatures produced by the Earth orientation on the second Shuttle flight.

In the next mission, a planned seven-day flight, NASA scientists will gain more extensive data on the rate of decline in the amount of offgassing contaminants, the effects on the bay area in different thermal orientations, any effects of different

**STS-3 Crew**—Astronaut Jack R. Lousma (left), commander, and C. Gordon Fullerton, pilot, of the third Shuttle mission wearing modified USAF-type high altitude pressure garments in their Earth-bound Shuttle trainer at NASA's Johnson Space Center, Houston, Texas.

payloads and the effects of an extensively cleaned Orbiter Processing Facility. Time permitting during the flight, the monitor will map effluents utilizing the Remote Manipulator System to maneuver the monitor to selected points around the orbiter.

The monitor was returned to the Marshall Center Dec. 7, 1981, and placed in a "clean room" in the center's Test Laboratory where the instruments were removed for analysis and refurbishment. The film and samples to be analyzed in the laboratory were removed within a few hours after arrival at Marshall and the tape recorder containing the bulk of the data from the monitor was also removed and taken to Marshall's Computer Services Office for data reduction.

**Women in Space**—Photographic reproduction of a poster which pays tribute to women involved in the exploration and study of space. The eight women inset are part of NASA's astronaut corps. The two women at the top of the sphere are from NASA astronaut group 9 who began training in 1980. The other six astronauts are from Group 8, who began training in 1978. Clockwise from upper left are Mary L. Cleave, Bonnie J. Dunbar, Judith A. Resnick, Anna L. Fisher, Kathryn D. Sullivan, Rhea Seddon, Sally K. Ride, and Shannon W. Lucid. In the center is a "fish eye" lens view of the interior of the forward section of the flight deck of the Space Shuttle Columbia.

## Contractor News

**Martin Marietta Denver Aerospace**, Denver, Colo., has been awarded a multi-million dollar addition to an existing contract with NASA's Kennedy Space Center, Fla. The value of the contract addition is $9,078,367, bringing the total value of the contract since 1975 to $111,193,217. Martin Marietta will provide the hardware for the checkout, control and monitor subsystem in Firing Room 3 of Kennedy's Space Shuttle Launch Control Center, which is now being prepared for regular Shuttle operations. The company will also provide some similar equipment for the Shuttle Launch Processing System at Vandenberg Air Force Base, California. The checkout, control and monitor subsystem is composed of consoles, mini-computers, a large mass storage unit and related equipment. It is used to actually process and launch the Space Shuttle. Firing Room 3 will be a duplicate of Firing Room 1, from which the Shuttle's developmental launches have been controlled. Firing Room 2, located between 1 and 3, will be used to develop software for the subsystem.

NASA's **Lewis Research Center** has awarded **two contracts** totaling $19,970,440 in **support of the Atlas Centaur launch vehicles** program. Launch operations and test support services will be managed under an $18,751,060 contract awarded to **General Dyamics Corp., Convair Division**, San Diego, Calif., and management, engineering, logistics and related support for the inertial measurement group for Centaur will be managed under a $1,219,380 contract given to **Honeywell, Inc., Avionics Division**, St. Petersburg, Fla. The inertial measurement group is part of the Centaur self-contained automatic navigation and guidance system. Both contracts are cost-plus-award-fee contracts and are continuations of work performed under earlier contracts. Both contracts become effective immediately, with the Convair contract continuing through June 1983 and Honeywell through December 1982.

**Rockwell International Corp., Rocketdyne Division**, Canoga Park, Calif., has been awarded a $2.9 million contract by NASA's Lewis Research Center, Cleveland, for engineering and logistics support for the Atlas launch vehicle. The 18-month cost-plus-fixed-fee contract became effective January 1, 1982. This procurement is a continuation of work performed under earlier contracts with Rocketdyne for similar services. The engineering and support activities will be carried out principally at the Rocket-

dyne plant in Canoga Park and at the Eastern Space and Missile Center, Florida. During the next 12 months the Atlas/Centaur launch vehicle is scheduled to launch three advanced INTELSAT Telecommunications Satellites. Atlas is the first stage of the Atlas/Centaur launch vehicle.

**ILC Dover,** Frederica, Del., has won a multimillion dollar contract to furnish protective clothing for workers exposed to hazardous conditions at NASA's John F. Kennedy Space Center and at the future Space Shuttle launch site at Vandenberg Air Force Base, Calif. The contract is for $4,792,910 and covers the period from Dec. 18, 1981 to Nov. 30, 1984. The firm will provide 436 garments known as SCAPE suits. SCAPE stands for Self-Contained Atmospheric Protective Ensemble. The suits are worn when workers are exposed to hazardous conditions, such as a spill of toxic fuel, and provide about two hours' protection. They provide temperature control and a constant supply of clean, filtered air. The contract is a joint NASA/Air Force procurement.

**WILTECH of Florida Corp., Inc.,** Titusville, Fla., has been selected by NASA's Kennedy Space Center for negotiations leading to an award of a contract for Space Shuttle component refurbishment and chemical analysis services. The contract's value and an exact statement of work will be the subject of the negotiations. The new contract will cover maintenance and refurbishment of ground support equipment and some flight hardware, such as hydraulic and pneumatic valves, regulators, cylinders, filter assemblies, gauges and several types of hoses. The company will service items to serve as spares or line replaceable units. Other services will include sampling and chemical analysis of various fluids and gases to determine purity and identify contaminants. Examples of items to be sampled include both gaseous and liquid nitrogen, oxygen, helium, hydrogen and air. The new contract is the result of a small business set aside, and will extend for one year with three additional one year option periods. Services will be performed primarily at Kennedy Space Center and Cape Canaveral Air Force Station.

**Winglet Flight Testing**—NASA's Dryden Research Facility, Edwards, Calif., has flown the first flight of a modified USAF jet cargo/tanker aircraft that could provide significant fuel savings. Winglets, nine-foot long airfoil sections, have been attached to the wingtips of a KC135. They are expected to improve the overall performance of the aircraft in cruise flight by approximately eight percent. Winglets are two feet wide at the tip and six feet wide at the base and weigh about 215 pounds each. They are designed to convert a portion of the normal drag that is produced by the wingtip vortices into a forward force which increases the overall performance of the aircraft.

## Space Shuttle Launches for 1982

| Orbiter | Launch Date | Launch Site | Payload |
|---|---|---|---|
| Columbia (OV-102) | March 22 | KSC | OSS-1 |
| Columbia (OV-102) | July | KSC | DOD 82-1 |
| Columbia (OV-102) | November | KSC | SBS-C, Telesat-E |

## Expendable Launches for 1982

| Name | Launch Date | Vehicle | Range | Mission Remarks |
|---|---|---|---|---|
| *RCA-C[1] | January 15 | Delta | ESMC | RCA communications. Reimbursable. |
| Westar-IV | February 25 | Delta | ESMC | Western Union communications. Reimbursable. |
| Intelsat V-D | March 4 | Atlas Centaur | ESMC | Intelsat communications. Reimbursable. |
| Insat 1A | April 8 | Delta | ESMC | India communications. Reimbursable. |
| NOAA-E/SAR | June | Atlas-73E | WSMC | NOAA/SAR weather. Reimbursable. |
| Navy 21 | June | Scout | WSMC | DOD transit. Reimbursable. Callup. |
| Intelsat V-E | July | Atlas Centaur | ESMC | Intelsat communications. Reimbursable. |
| Landsat-D | July | Delta | WSMC | NASA earth resources applications. |
| Telesat-G (Anik-D1) | August | Delta | ESMC | Canada communications. Reimbursable. |
| Westar-V | September | Delta | ESMC | Western Union communications. Reimbursable. |
| RCA-E | October | Delta | ESMC | RCA communications. Reimbursable. |
| San Marco-D/L | November | Scout | ESMC | International cooperative/Italy. |
| Intelsat VA-A | December | Atlas Centaur | ESMC | Intelsat communications. Reimbursable. |

*Successful launch

## Patents for Inventions from NASA Research

*The office of General Counsel, NASA Headquarters, announces that the following U.S patents have been issued by the U.S. Patent and Trademark Office to NASA for inventions resulting from NASA research. Inquiries concerning them should be directed to the attention of the NASA Patent Counsel of the indicated installation.*

| Inventor(s) & Employer | Title | Patent No. | Installation |
|---|---|---|---|
| Leopold A. Hein and William N. Myers, NASA/MSFC | Amplified wind turbine apparatus | 4,309,146 | MSFC |
| Dean W. Sheibley NASA/LeRC | Formulated plastic separators for soluble electrode cells | 4,309,372 | LeRC |
| Stephen C. Irick, NASA/LaRC | Continuous self-locking spiral wound seal | 4,309,039 | LaRC |
| John H. Cantrell, Jr. and Joseph S. Heyman, NASA/LaRC, and William T. Yost and Michael A. Torbett, Univ. of Tenn. | Liquid-immersible electrostatic ultrasonic transducer | 4,310,906 | LaRC |
| Robert K. Robinson and Harry M. Thomlinson, Boeing Commercial Airplane Company, Seattle, Wash. | Fuselage structure using advanced technology metal matrix fiber reinforced composites | 4,310,132 | LaRC |
| Daniel L. Deadmore and Stanley G. Young NASA/LeRC | Silicon-slurry/aluminide coating | 4,310,574 | LeRC |
| Murzban D. Jhabvala, NASA/GSFC | Implantable electrical device | 4,308,868 | GSFC |
| Larry T. Taylor, Anne K. St. Clair, Vicki C. Carver and Thomas A. Furtsh, Virginia Poly-Technic Institute & State University Blacksburg, Va. | Electrically conductive palladium containing polyimide films | 4,311,615 | LaRC |
| Frank Lombardi, Caltech/JPL | Hermetic seal for a shaft | 4,311,057 | NRO |
| Amal M. Salama, Caltech-JPL | Improving the efficiency of silicon solar cells containing chromium | 4,311,870 | NRO |
| Thomas A. Shull, NASA/LaRC Hampton, Va. | Digital demodulator | 4,313,103 | LaRC |
| Walter Haeussermann, NASA/MSFC Huntsville, Ala. | Magnetic field control | 4,313,077 | MSFC |

# Another Dividend from Air and Space

**Research and development in aeronautics and space have provided numerous benefits for all Americans—and at a tiny percentage of the tax dollar. Here is an example:**

## Talking Wheelchair

A spinoff of technology developed at NASA's Ames Research Center, Mountain View, Calif., for advanced aircraft communications is an electronic system which produces highly intelligible synthesized speech. It is known familiarly as the "talking wheelchair" and formally as the Versatile Portable Speech Prosthesis (VPSP).* The VPSP was developed by Stanford University Medical Center, Stanford, California and Psycho-Linguistic Research Associates, Menlo Park, California with NASA-Ames funding assistance. Other participants include personnel of Ames Research Center, the NASA Biomedical Application Team at Stanford, and Children's Hospital at Stanford.

The wheelchair-mounted system consists of a word processor, a video screen, a voice synthesizer and a computer program which instructs the synthesizer how to produce intelligible sounds in response to user commands. To save time, the computer's memory contains 925 words plus a number of common phrases and questions from which users can construct messages; the memory can also store several thousand other words of the user's choice. Any word not already in the memory can be entered, one letter at a time, and the VPSP will pronounce it. Depending on the user's disability, message units are selected by operating a simple switch, a joystick or a keyboard. The completed message appears on the video screen; then the user activates the speech synthesizer which generates a voice with a somewhat mechanical tone. Continuing research aims at development of a more natural tone. With the keyboard, an experienced user can construct messages as rapidly as 30 words per minute.

The NASA technology used in the VPSP was developed as an aid to pilots who experience critical aircraft malfunctions. To free the pilot from the necessity for watching several instruments during the emergency, Ames Research Center developed experimental systems to provide synthesized voice readout of aircraft altitude, airspeed, descent rate and deviation from flight path. VPSP co-developer Dr. Carol Simpson, formerly a NASA researcher and now with Psycho-Linguistic Research Associates, applied this technology to the talking wheelchair.

The VPSP offers potential for people—some 1,500,000 in the United States alone—who have lost speech function as a result of such afflictions as stroke, cerebral palsy, muscular dystrophy, Parkinson's disease or multiple sclerosis. A company— Computers for the Physically Handicapped, Huntington Beach, California—has expressed interest in commercial production of the VPSP system and negotiations are underway.

*NASA does not endorse commercial products developed as a result of its Technology Utilization or Patent Licensing Programs, but it does encourage the widest possible use of its technology.

NASA
National Aeronautics and Space Administration

**For the benefit of all . .**